APPENDIX C

METEOROLOGICAL CRITICAL VALUES

Meteorological critical values are those values which reduce significantly the effectiveness of tactical operations and/or weapon systems. Significant variations above or below critical values can prevent the successful completion of a mission. Therefore, the SWO must be aware of critical values and must consider them in all forecasts.

This appendix provides a table of critical values for specific and branch operations. It does not, however, provide absolute values for every operation or weapon system on the battlefield. Critical values must be weighed against the tactical situation and the mission. Although weather personnel forecast and call attention to critical factors, only commanders decide which values are critical for each operation. Additional input from terrain analysis teams and other sources and the criticality of the mission are weighed by the commander in reaching a decision. Figure C-1 shows some meteorological critical values for specific and branch operations.

Weather information frequently is color coded to help the decision maker quickly assess the impact of weather on impending operations and decisions. This person normally is the tactical unit commander whom the WETM supports. The following color code is suggested for consistency within the operational commands:

- GREEN (Favorable): weather has no restrictions.
- AMBER (Marginal): weather degrades or limits.
- RED (Unfavorable) : weather prohibits.

AIRBORNE OPERATIONS

ELEMENTS	CRITICAL VALUES	IMPACTS
Ceiling--cloud and sky cover	<= 300 ft (90 m) flat terrain	Mission planning - day, jump altitude; aircraft penetration.
	<= 500 ft (150 m) flat terrain	Mission planning - night, jump altitude; aircraft penetration.
	<= 500 ft (150 m) mountain terrain	Target acquisition - day.
	<= 1,000 ft (300 m) mountain terrain	Target acquisition - night.
	<= 10,000 ft mountain terrain	Mission planning for LZ or DZ.
Surface visibility at the following visible wave lengths: 3.47 ft (1.06 m) 10 to 16.4 ft (3 to 5 m), 26.2 to 39.6 ft (8 to 12 m)	<= 1/4 mile (400 m)	Mission planning - infrared sensors.
		Navigation and target acquisition - rotary wing.
	<= 1 mile (1,600 m)	Day mission planning - minimum takeoff or landing, minimum fixed wing.
	<= 3 miles (4,800 m)	Night mission planning - minimum takeoff or landing, minimum fixed wing.
Wind (Surface)	<= 13 knots	Troop safety for paradrop operations; limiting value for operations during training.
	<= 15 knots (<= 21 knots for C-12 and U-21)	Mission planning and aircraft; safety on recovery.

Figure C-1. Meteorological critical values.

ELEMENTS	CRITICAL VALUES	IMPACTS
	25 knots (OV-1) <= 30 knots and/or gust speeds	Mission planning and aircraft; safety on recovery.
Winds (Aloft)	<= 40 knots	Jump point; planning for flight route and duration.
Precipitation	Any intensity or type	Rate of troop fall and target acquisition.
Thunderstorms and Lightning	Any occurrence	Restricts aircraft performance; limits aircraft refueling; reliability or communications systems; predetonation of certain munitions.
Temperature (Surface)	32.0°F (0°C)	Ground conditions.
Pressure altitude	100 ft	Parachute opening altitude.
Density altitude: Variable with aircraft, weight, power, and temperature.	6,900 ft >4,000 ft >2,000 ft	Planning; cargo limits. Weight limits for attack and OH-58. OH-58 limit troop configuration.
Effective illumination	<= 10-3 frequency	Planning of night missions; navigation safety.
	AVIATION AND AIR ASSAULT OPERATIONS	
Ceiling--cloud and sky cover	<= 300 ft (90 m)	Nap-of-the-earth planning and acquisition - rotary wing.
	<= 300 ft (90 m) flat terrain	Daylight target acquisition - fixed wing.
	<= 500 ft (150 m) mountain terrain	Daylight target acquisition - fixed wing.
	<= 500 ft (150 m) flat terrain	Night target acquisition - fixed wing.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
	<= 1,000 ft mountain terrain	Night target acquisition - fixed wing.
Visibility (Surface)	<= 1/4 mile (400 m)	Navigation and target acquisition - rotary wing.
	<= 1 mile (1,600 m)	Landing and takeoff minimums for mission planning.
	<= 3 miles (4,800 m)	Landing and takeoff minimums for mission planning.
Visibility (Slant range)	<= 1/4 mile (400 m)	Navigation and target acquisition - rotary wing.
	3 miles (4,800 m) mountain terrain	Navigation and target acquisition - rotary wing.
Wind (Surface)	>30 knots 15-knot gust spread (21 knots C-21 and U-21) (25 knots OV-1)	Mission planning, aircraft safety.
Winds (Aloft)	>30 knots	Mission planning - duration.
Precipitation	Any freezing	Rotorblade icing, aircraft survivability and damage.
	>0.5 inch per hour - liquid	Target acquisition.
Hail	>= 1/4 inch in diameter	Aircraft damage.
Snow depth and cover	>1 inch (2.54 cm) powder	Location of LZ and DZ; vertigo.
Icing	>= Light (clear/rime)	Mission planning and safety; ordnance delivery restrictions - rotary wing.
Turbulence	Moderate	Mission planning, aircraft survivability.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
Thunderstorms and lightning	Any occurrence within 3 miles (4,800 m) of site	Safety and fuel operations.
Density altitude variable with aircraft, weight allowable, power, and temperature.	6,900 ft (2,103 m)	Flight control, runway limits, takeoff, and landing; compute maximum gross weight.
Effective illumination	<= 10-3 footcandles	Mission planning for night operations.
	AIR DEFENSE OPERATIONS	
ELEMENTS	CRITICAL VALUES	IMPACTS
Ceiling--cloud and sky cover	<= 500 ft	Selection of weapon systems and positioning for convoy.
	<= 5,000 ft	Aircraft detection and identification.
Visibility (Surface)	2 miles	Aircraft detection and identification for short-range air defense systems--ROLANDS, Vulcan, and Chaparrel.
	<3 miles	Weapon systems selection and placement for the Stinger and Redeye.
Wind (Surface)	>30 knots	Communications and radar antenna affected.
	>50 knots 57 knot gusts	Weapon systems selection and planning reconnaissance figure and inspect Hawk, Patriot, and Hercules.
Winds (Aloft)	>50 knots	Aiming and tracking.
Precipitation	>0.5 inch (1.27 cm) per hour liquid	All radar >10 GHz degraded; all infrared sensors affected.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
Thunderstorms and lightning	Any occurrence within 1.2 miles (2 km) of site	Affects communications, radar, and storage and protection of missile systems.
Temperature (Surface)	>120.2°F (49°C) <-45.5°F (-43°C)	Mission planning for use of Chaparrel, Redeye, and Stinger.
	<-65.2°F (-54°C)	Mission planning for use of Vulcan.
Windchill	<= -25.6°F (-32°C) 1-minute exposure	Personnel protection; plan gear and equipment needs.
	<= -74.2°F (-59°C) 1-second exposure	Personnel protection; plan gear and equipment needs.
Effective illumination	<= 10-3 foot candles	Target acquisition or aircraft.
Movement of systems	SEE GROUND MANEUVER OPERATIONS.	
	AMPHIBIOUS OPERATIONS	
Ceiling--cloud and sky cover	<= 1,000 ft (300 m)	Concealment; planning CAS.
Visibility (Surface)	<= 1 mile (1,600 m) (1.6 km)	Target acquisition.
Wind (Surface)	>= 7 knots	Personnel landing and smoke operations.
	>= 35 knots	Affects wave and surf limits.
Temperature (Surface)	>89.6°F (32°C)	Affects personnel and equipment support.
	<32.0°F (0°C)	Affects planning for logistic support, fuels, and expendable supplies.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
Windchill	<= -25.6°F (-32°C) 1-minute exposure	Troop safety.
	<= -74.2°F (-59°C) 1-second exposure	Troop safety.
Precipitation	>0.1 inch (2.54 cm) per hour liquid	Affects shore trafficability.
Effective illumination	<= 10-3 footcandles	Planning night landing operations and concealment.
Littoral current	Any underlying current or riptide >3 knots	Mission planning.
Tides (provided by the Navy)	Variable threshold of watercraft	Type of watercraft required; timing of mission.
Temperature (water)	>86°F (30°C)	Personnel safety.
Shore trafficability	Variable with equipment	Planning shore vehicle operations.
State-of-the-sea	>3.0 ft (1 meter) waves	Dictates airborne versus water operation.
Surf breaker description	Surging surf > 4 ft (1.2 m) breakers	Mission planning.
Surf zone	Area covered by surf	Mission planning.
Ground mobility	SEE GROUND MANEUVER OPERATIONS.	
	ENGINEER OPERATIONS	
Ceiling--cloud and sky cover	<= 500 ft	AO and location of facilities; personnel safety; aerial reconnaissance; camouflage needs.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
Visibility (Surface)	<= 1/4 mile	Mission planning; concealment and cover.
Wind (Surface)	>= 13 knots	Construction and stability or bridges and structures.
Precipitation	>0.5 inch per hour liquid	Need for mines reduced; loading and offloading operations.
Snow depth and cover	>2 inch in a 12-hour period	Some AO and locations of locations of facilities; stability of bridge structures; types of demolitions to be used, size and charge; blast from trigger mechanisms may render mines ineffective.
Freeze and thaw depth	6 inches	Trafficability determination.
Thunderstorms and lightning	Any occurrence within 0.6 miles (1 km) of site	Equipment and personnel safety; munitions protection.
Temperature (ground)	-< 32°F (0°C)	Freeze or thaw depth determination, construction material; precipitation at or below 32°F (0°C) poses a threat for personnel and may cause structural damage; may curtail some operations.
Humidity	>35%	Comfort, equipment operations, and site selection planning.
	FIELD ARTILLERY OPERATIONS	
Ceiling--cloud and sky cover	<= 600 m (2,120 m)	Target acquisition. Affects copperhead performance.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
Visibility--slant range at the following wave lengths: 3.47 ft (1.06 m), 10 to 16.4 ft (3 to 5 m), 26.2 to 39.36 ft (8 - 12 m) wavelengths.	<= 1 mile (1.5 km)	Target acquisition.
Wind vertical profile	>5 knot change per 3,280.8 ft (1.1 km)	Affects UAV operations; nuclear fallout prediction; TACFIRE requirement-artillery fire.
Thunderstorms and lightning	Any occurrence within within 3 miles (4,800 m)	Safety and storage of munitions; erection of missile hampered.
Effective illumination	<= 10-3 footcandles	Mission planning for night artillery operations.
	INTELLIGENCE AND ELECTRONIC WARFARE OPERATIONS	
Ceiling--cloud and sky cover	=200 ft (60 m)	Degrades engagement range.
	<= 1,000 ft (300 m)	Degrades aerial observation.
Surface visibility at the following wave lengths: visible, 3.47 ft (1.06m), 10 to 16.4 ft (3 to 5 m), 26.2 to 39.6 ft (8 to 12 m)	<1 mile (1,600 m)	Essential to determine enemy's ability to conceal actions; locating and identifying targets.
Wind (Surface)	>60 knots	Equipment damage.
Precipitation	>0.1 inch (.254 cm) per hour liquid	Audio sensors and radar effectiveness reduced.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
	>0.5 inch (1.27 cm) per hour liquid	Reduces speed of personnel and equipment movement.
	>2.0 inch (5.08 cm) in a 12-hour period	Reduces speed of personnel and equipment movement.
Snow depth and cover	>6 inch (15 cm) >24 inch (60 cm)	Reduces trafficability.
Thunderstorms and lightning	Any occurrence within 3 miles (4,800 m)	Troop and equipment safety; false alarms and false reading.
Temperature (Surface)	>122.0°F (50°C) <-58.0°F (-50°C)	Emplacement site selection.
Temperature (Ground)	<32°F (0°C)	Trafficability assessment.
WBGT	>85°F (29.4°C)	Troop safety.
Electromagnetic propagation	Subrefraction or superfraction	Ducting of radar transmission and return.
Effect illumination	<= 10-3 footcandles	Target acquisition.
River stage and current strength	>6 ft (2 meters) depth	Affects enemy's ability to cross rivers or streams.
Precipitation	>2.0 inch (5 cm) in a 12-hour period	Trafficability; storage of equipment.
SEE AVIATION AND AIR ASSAULT FOR ADDITIONAL WEATHER EFFECTS ON FIXED-WING OR ROTARY-WING AIRCRAFT.		
	LOGISTICS	
Snow depth and cover	>2.0 inch (5 cm)	Trafficability.
Freeze and thaw depth	6 inches (15 cm)	Site and equipment selection, mobility.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
Thunderstorms and lightning	Any occurrence within 3 miles (4,800 m)	Equipment, personnel, and munitions safety.
Temperature (Surface)	>122.0°F (50°C) <-25.6°F (-32°C)	Affects storage and required temperature control for movement of medicines; munitions storage.
Humidity	>70%	Affects storage of selected supplies and munitions.
Coastal operations	SEE AMPHIBIOUS OPERATIONS.	
	GROUND MANEUVER OPERATIONS	
Ceiling--cloud and sky cover	<= 1,000 ft (300 m)	Concealment and cover from threat surveillance; TACAIR and aerial supply support; affects background contract for target acquisition or using thermal devices.
Surface visibility at the following wave lengths: visible, 3.47 ft (1.06 m), 10 to 16.4 ft (3 to 5 m), 26.2 to 39.6 ft (8 to 12 m)	Dragon and Viper <2,624.57 ft (800 m) Tow < 5,249.3 ft (1,600 m)	Target acquisition; system selection.
Wind (Surface)	>7 knots	Affects smoke operations; background radar noise.
	>20 knots	Creates visibility restriction in blowing sand and snow; soil drying aerial resupply; windchill effect on equipment and personnel.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
	>30 knots	Accuracy of antitank missiles.
	>75 knots	Antenna failure.
	>125 knots	Equipment (van) failure.
Precipitation	>0.1 inch (.254 cm) per hour liquid >2.0 inch (5 cm) in a 12-hour period	Soil type affected by temperature and moisture; vehicle movement; site location, river levels, runoff, flooding, delays resupply, demolitions, river crossing, visibility, target acquisition, and radar effectiveness.
Snow depth and cover	>2.0 inch (5 cm) in a 12-hour period >6 inch (15 cm) >24 inch (60 cm)	Effectiveness of mines reduced; choice of construction materials; trafficability.
Freeze and thaw depth	6 inches (15 cm)	Off-road employment of wheeled and tracked vehicles.
Thunderstorms and lightning	Any occurrence within 3 miles (5 km) (4,800 m)	Munition safety; personnel communications equipment safety.
Temperature (Surface)	>= 122°F (50°C)	Affects thermal sights.
	>89.6°F (32°C)	Affects lubricants, personnel, and infrared sensors.
	>32°F (0°C)	Melting snow and ice affects river crossing sites and offroad movements.
	<32°F (0°C)	Drying of soil; affects freeze or thaw depth.
	Any change of 50°F (10°C)	Affects munitions trajectories.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
Windchill	<= -25.6°F (-32°C) 1-minute exposure <= -74.2°F (-59°C) 1-second exposure	Reduces time before exposed flesh will suffer frostbite.
Effective illumination	<= 10-3 footcandles	Affects use of night vision devices.
Seashore conditions--provided by the Navy	Current and Tide >6.22 mph (10 km)	Affects beach and port sea-to-shore loading and offloading operations.
	Waves >3 ft (1 m) Swell >3 ft (1 m) Surf 5 to 6 ft (1.52 to 1.82 m)	Impedes landing operations.
	MILITARY POLICE OPERATIONS	
SEE GROUND MANEUVER OPERATIONS FOR THOSE ELEMENTS IMPACTING ON MILITARY POLICE OPERATIONS.		
	NUCLEAR, BIOLOGICAL, CHEMICAL OPERATIONS	
Ceiling--cloud and sky cover	<= 5,000 ft (1.5 km)	Impacts on aerial deployment agents; enhances thermal effects if burst is below clouds; reduces thermal and EMP effects if burst is above clouds.
Visibility (Surface)	<1,312 ft (400 m) <3,280 ft (1 km) <9,842.5 ft (3 km)	Determines smoke generator necessary to maintain desired smoke screen.
Visibility (Slant range)	<3,280 ft (1 km)	Needed if agents are delivered by TAC.
Wind (Surface)	>3 knots but <7 knots	Favorable for NBC operations.
	>10 knots	Unfavorable for NBC operations.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
	>15 knots	With winds above this speed, munition accuracy--first round is especially important for chemical dispersion since the enemy masks in 9 seconds.
Precipitation	Any intensity or type	Washes agents and smoke out of the atmosphere; causes nuclear hot spots.
Thunderstorms and lightning	Any occurrence within 3.1 miles (5 km) of site	Troop and munition storage safety.
Temperature (Surface)	>95°F (35°C)	Affects rate of evaporation of liquid chemical agents; dispersion of aerosols, high risk of injury in MOPP IV.
	>68°F (29°C)	Moderate risk of heat illness in persons in MOPP IV.
	<32°F (0°C)	Climate extremes determine the type of shelter; indirectly affecting troop vulnerability to nuclear radiation; indirect thermal radiation effect due to type of troop clothing.
Temperature (Vertical gradient or profile)	Reversal from stable to unstable	Reduces the time agents or smoke will remain in an area.
	or	
	Reversal from unstable to stable	Increases time agents or smoke will remain in an area.
Humidity	>60%	Affects agent effectiveness dispersion of snow blister agents; very effective in hot, humid weather.
Effective illumination	<= 10-3 footcandles	Needed for night operations of NBC equipment.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
	SIGNAL COMMUNICATION OPERATIONS	
Wind (Surface)	>7 knots	Creates radar background noise.
	>25 knots	Safety and stability for installing LOS and troposcattering antennas; once up, the antennas can withstand a constant wind of 65 knots with gusts up to 85 knots.
	>69 knots	Wind damage to main communications antenna-linear pole.
	>78 knots	Safety and stability of single-channel radio and short-range, wide-band radio antennas.
Precipitation	Any occurrence of freezing	Damage to equipment and antennas; affects wind tolerances of antennas; affects troop safety.
	>0.5 inch (1.27 cm) per hour liquid	Blocks troposcatter transmission and decreases radar range; any precipitation attenuates the signal for single-channel radio (AM or FM), short-range wide-band radio, and LOS communications.
Snow depth and cover	>6 inch (15 cm) >24 inch (60 cm)	Site and equipment location; install and maintain cable, wire, and systems.
Thunderstorms and lightning	Any occurrence within 3 miles (4,800 m)	Damage to equipment; interferes with radio signals, especially HF signals.
Temperature (Surface)	<-13°F (-25°C)	Batteries of PRC-77 and VRC-12 series radios will not operate.
	<-40°F (-40°C)	Degrades humes and linear pole antennas.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
Temperature (vertical gradient or profile)	All significant inversions	Cause fading of tropospheric during use of troposcatter equipment.
Ionospheric disturbances	NA	Dictates most usable frequencies for communications.
SEE GROUND MANEUVER OPERATIONS FOR ADDITIONAL WEATHER EFFECTS ON PERSONNEL AND EQUIPMENT MOBILITY.		
	SPECIAL FORCES OPERATIONS	
Ceiling--cloud and sky cover	<= 300 ft (90 m)	Necessary for acquisition of target area while maintaining confidentiality of UW.
	<= 1,000 ft (300 m)	Planning TACAIR support and for cover and concealment.
Visibility (Surface)	1/4 mile (400 m)	Acquisition of target area while maintaining confidentiality of UW.
Visibility (Slant range)	<= 1/2 mile (800 m)	Target acquisition, concealment and cover.
Wind (Surface)	>5 knots	Dictates area covered, drop point and altitude, and bundle size for leaflet drops.
	>7 knots	Mission planning for waterborne operations; affects wave and surf conditions and safety of landing operations.
	>15 knots	Troop safety and navigation of steerable parachute.
	>25 knots	Affects installation of antennas during setup operations.

Figure C-1. Meteorological critical values (Continued).

ELEMENTS	CRITICAL VALUES	IMPACTS
	>69 knots	Wind damage on main communication antenna.
Winds (Aloft)	>20 knots surface to 1,000 ft 1,000 to 5,000 ft	Troop safety and navigation of steerable parachute.
Precipitation	>0.1 inch (.254 cm) per hour liquid	Rate of fall; acquisition of target area; affects leaflet dispersion.
Snow depth and cover	>1 inch (2.54 cm) per hour	Degrades transmission effectiveness.
Thunderstorms and lightning	Any occurrence within 3.1 miles (5 km) of site	Degrades communications; safety personnel and equipment.
Temperature (Surface)	>95°F (35°C) <-40°F (-40°C)	Troop safety; planning equipment support requirement. Communications can be degraded; cables become brittle and break.
Ionospheric disturbance	NA	Dictates most usable frequencies for communications.
Effective illumination	<= 10-3 footcandles	Concealment and cover; minimum light needed for operations.
Tides	>6 ft (2 m)	Affects safety of landing operations.
State-of-the-sea (provided by the Navy)	Swell and surf >3 ft (1 m) Chop > 3 ft (1 m)	Troop safety; mission accomplishment; dictates airborne entry.
Littoral current	Any current > 3 knots	Safety of personnel; mission accomplishment.
Surf	>4 ft (1.2 m) breakers	Mission accomplishment.

Figure C-1. Meteorological critical values (Continued).